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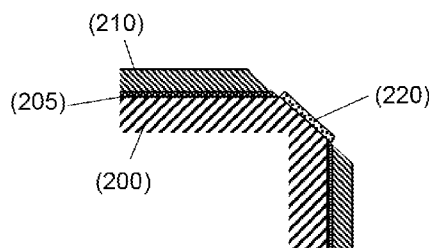


Figure 2

(57) Abstract: A housing for an electronic device is described. The housing comprises a substrate, which comprises a magnesium alloy. The substrate has a first coated surface and a second coated surface. The first coated surface comprises an oxidized layer or at least one coating layer. The second coated surface comprises a layer coated on a non-oxidized surface of the substrate. The layer comprises (i) a chelating agent and a metal ion or a chelated metal complex thereof, or (ii) a sol-gel coating or a sol-gel hybrid coating.



HOUSINGS FOR ELECTRONIC DEVICES

BACKGROUND

[0001] Electronic devices, such as laptops and mobile phones, include various components located within a housing. These devices are frequently subjected to mechanical deformation when they are placed in contact with other objects, such as a person's hand, a table or the ground. The housings that form the electronic devices should be able to tolerate such mechanical deformation and withstand wear and tear from regular use.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] Figure 1 is a flow chart showing a method of manufacturing a housing for an electronic device.

[0003] Figures 2 to 7 each show, in an example, a partial cross-section through part of a housing for an electronic device.

[0004] Figure 8 shows a housing for a laptop.

[0005] The figures depict several examples of the present disclosure. It should be understood that the present disclosure is not limited to the examples depicted in the figures

DETAILED DESCRIPTION

[0006] As used in the present disclosure, the term "about" is used to provide flexibility to an endpoint of a numerical range. The degree of flexibility of this term can be dictated by the particular variable and is determined based on the associated description herein.

[0007] Amounts and other numerical data may be expressed or presented herein in a range format. It is to be understood that such a range format is used merely for convenience and brevity and thus should be interpreted flexibly to include not just the numerical values explicitly recited as the limits of the range, but also to include individual numerical values or sub-ranges encompassed within that range as if each numerical value and sub-range is explicitly recited.

[0008] As used in the present disclosure, the term “disposed” when used to refer to the location or position of a layer includes the term “deposited” or “coated”.

[0009] As used in the present disclosure, the term “comprises” has an open meaning, which allows other, unspecified features to be present. This term embraces, but is not limited to, the semi-closed term “consisting essentially of” and the closed term “consisting of”. Unless the context indicates otherwise, the term “comprises” may be replaced with either “consisting essentially of” or “consists of”.

[0010] It is noted that, as used in this specification and the appended claims, the singular forms “a”, “an” and “the” include plural referents unless the context clearly dictates otherwise.

[0011] The present disclosure refers herein to a housing for an electronic device, to a method of manufacturing a housing and to an electronic device.

[0012] The housing comprises a substrate. The substrate comprises a magnesium alloy, and the substrate has a coated surface. The coated surface comprises a layer coated on a non-oxidized surface of the substrate. The layer comprises (i) a chelating agent and a metal ion or a chelated metal complex thereof, or (ii) a sol-gel coating or a sol-gel hybrid coating.

[0013] The substrate may have a first coated surface and a second coated surface. The first coated surface may be different to the second coated surface.

[0014] When the substrate has a first coated surface and a second coated surface, then the second coated surface comprises the layer comprising (i) a chelating agent and a metal ion or a chelated metal complex thereof, or (ii) a sol-gel coating or a sol-gel hybrid coating. The layer is coated on a non-oxidized surface of the substrate. The first coated surface comprises an oxidized layer or at least one coating layer.

[0015] The electronic device comprises an electrical circuit and a housing external to the electrical circuit.

[0016] The method of manufacturing the housing for an electronic device involves coating a substrate with (i) a layer comprising a chelating agent and a metal ion or a chelated metal complex thereof, or (ii) a sol-gel coating or a sol-gel hybrid coating. The substrate comprises a magnesium alloy.

[0017] When the substrate has a first coated surface and a second coated surface, then the method may comprise cutting a first coated surface of a substrate to expose a non-oxidized surface of the substrate. The first coated surface comprises an oxidized layer or at least one coating layer. The non-oxidized surface of the substrate is then coated with (i) a layer comprising a chelating agent and a metal ion or a chelated metal complex thereof, or (ii) a sol-gel coating or a sol-gel hybrid coating. This coating may form the second coated surface.

[0018] It is to be understood that this disclosure is not limited to the housings, electronic devices or methods disclosed herein. It is also to be understood that the terminology used in this disclosure is used for describing particular examples.

Substrate

[0019] The substrate may comprise a metal selected from aluminum, magnesium, lithium, titanium, zinc and alloy thereof. These metals are light-weight and can provide a durable housing.

[0020] The substrate may be an insert molded metal substrate. For example, the insert molded metal substrate may be formed by insert molding the metal with a plastic, such as a plastic selected from polybutylene terephthalate (PBT), polyphenylene sulfide (PPS), polyamide (nylon), polyphthalamide (PPA), acrylonitrile butadiene styrene (ABS), polyetheretherketone (PEEK), polycarbonate (PC), and ABS/PC with 15- 50% glass fiber filler.

[0021] In an example, the substrate comprises a magnesium alloy. When the substrate is made of a magnesium alloy, then the housing is mechanically durable, is light-weight and can provide an exterior metallic appearance. Magnesium alloys have a specific gravity that is about 70% that of aluminum, a high specific strength, and excellent heat removal characteristics. Electronic devices having a lighter and thinner housing can be manufactured when the substrate is made from a magnesium alloy.

[0022] Generally, the magnesium alloy comprises a content of magnesium of at least about 75 wt.%. For example, the magnesium alloy may comprise at least about 80 wt.% or at least about 90 wt.% of magnesium.

[0023] The magnesium alloy may further comprise aluminum, zinc, manganese, silicon, copper, a rare earth metal or zirconium. The aluminum content may be about 2.5 wt.% to about 13.0 wt.%. When the magnesium alloy comprises aluminum, then at least one of manganese, zirconium or silicon is also present. Examples of magnesium alloys include AZ31, AZ31B, AZ61, AZ60, AM60, AZ91, AZ91D, LZ91, LZ14 and ALZ alloys, according to the American Society for Testing and Materials standards.

First coated surface

[0024] The substrate may have a first coated surface where a first surface of the substrate is coated with at least one layer. The first coated surface may comprise an oxidized layer or a coating layer. When, for example, a magnesium alloy surface is exposed to air, it rapidly oxidizes and forms a dull surface that has an unattractive appearance. By applying a coating to a surface of the substrate, the underlying metallic substrate can be protected. Layers can also be applied to give the surface an attractive appearance.

[0025] When the first coated surface comprises an oxidized layer, this layer may comprise a passivation layer, an oxidized layer of the metallic substrate or both an oxidized layer of the metallic substrate and a passivation layer.

[0026] The passivation layer may comprise a salt selected from a molybdate salt, a vanadate salt, a phosphate salt, a chromate salt, a stannate salt and a manganese salt. In one example, the passivation layer comprises a phosphate salt. The passivation layer contains oxidic salts that can provide the first surface with a dark grey appearance.

[0027] In one example, when the substrate comprises a magnesium alloy, the oxidized layer of the metallic substrate is an oxidized layer of the magnesium alloy.

[0028] The oxidized layer of the metallic substrate may be a micro-arc oxide layer, such as a micro-arc oxide layer of the magnesium alloy. The micro-arc oxide layer may be obtainable from the method described herein.

[0029] The oxidized layer of the metallic substrate, including the micro-arc oxide layer, can have a thickness of from about 3 to about 15 μm . The passivation layer can have a thickness of from about 0.5 to about 5 μm .

[0030] Both an oxidized layer of the metallic substrate and a passivation layer may be present. In one example, the passivation layer can be deposited or coated on the oxidized layer of the magnesium alloy.

[0031] In another example, the oxidized layer can be a single layer, which is either a micro-arc oxide layer or a passivation layer. By itself, the micro-arc oxide layer or the passivation layer can prevent corrosion of the magnesium alloy.

[0032] The first coated surface may comprise at least one coating layer, such as two, three or four coating layers. Each coating layer may be selected from a base coating layer, a primer coating layer, a powder coating layer and a top coating layer. Each of these coating layers may be made of different material and may provide different functionality, such as heat resistance, hydrophobicity, and anti-bacterial properties.

[0033] The coating layer may be deposited or coated directly on to the first surface of the substrate. This means that there is no intervening oxidized layer between the coating layer and the first surface of the substrate.

[0034] The base coating layer may comprise a component selected from barium sulfate, talc, a dye and a color pigment. In one example, the base coating layer comprises a color pigment or a dye.

[0035] The base coating layer may further comprise a heat resistant material, such as a silica aerogel. The base coating layer can comprise a heat resistant material and a component as described above.

[0036] The base coating layer can have a thickness of from about 10 to about 25 μm , such as about 15 to about 20 μm .

[0037] In an example, the base coating layer comprises polyurethane-containing pigments. The base coating layer may further comprise at least one of carbon black, titanium dioxide, clay, mica, talc, barium sulfate, calcium carbonate, synthetic pigment, metallic powder, aluminum oxide, an organic powder, graphene, graphite, plastic beads, a color pigment or a dye. The organic powder may, for example, be an acrylic, a polyurethane, a polyamide, a polyester or an epoxide.

[0038] By using a base coating layer, other different coating layers can easily be deposited on the first surface, such as when the first surface has been coated with an oxide layer, and it may improve adhesion between different coating layers.

[0039] The primer coating layer may comprise a polyurethane or a filler selected from carbon black, titanium dioxide, clay, mica, talc, barium sulfate, calcium carbonate, a synthetic pigment, a metallic powder, aluminum oxide, carbon nanotubes (CNTs), graphene, graphite, and an organic powder. The organic powder may, for example, be an acrylic, a polyurethane, a polyamide, a polyester or an epoxide. The primer coating layer may, for example, comprise a polyurethane and a filler as described above.

[0040] A heat resistant material may be included in the primer coating layer. In an example, the primer coating layer contains a heat resistant material, a filler as described above and optionally a polyurethane.

[0041] The primer coating layer can have a thickness of from about 5 to about 20 μm .

[0042] The powder coating layer may comprise a polymer selected from an epoxy resin, a poly(vinyl chloride), a polyamide, a polyester, a polyurethane, an acrylic and a polyphenylene ether.

[0043] In an example, the powder coating layer is an electrostatic powder coating layer. The powder coating layer may be electrostatically deposited or coated onto a first surface of the substrate and then the polymer may be cured.

[0044] The powder coating layer may further comprise a filler selected from carbon black, titanium dioxide, clay, mica, talc, barium sulfate, calcium carbonate, a synthetic pigment, a metallic powder, aluminum oxide, carbon nanotubes (CNTs), graphene, graphite, and an organic powder. The organic powder may, for example, be an acrylic, a polyurethane, a polyamide, a polyester or an epoxide.

[0045] A heat resistant material may be included in the powder coating layer. In an example, the powder coating layer comprises a polymer, a filler and a heat resistant material.

[0046] The powder coating layer can have a thickness of from about 20 μm to about 60 μm , such as about 30 μm to about 50 μm .

[0047] The top coating layer comprises a polymer selected from a polyurethane, a polycarbonate, a urethane acrylate, a polyacrylate, a polystyrene, a polyetheretherketone, a polyester, a fluoropolymer and a mixture thereof.

Examples of fluoropolymers include fluoroacrylates, fluorosiliconeacrylates, fluorourethanes, perfluoropolyethers, perfluoropolyoxetanes, fluorotelomers, polytetrafluoroethylene (PTFE), polyvinylidene fluoride (PVDF), fluorosiloxane, fluoroUV polymers and hydrophobic polymers.

[0048] The top coating layer may be transparent.

[0049] The top coating layer may have hydrophobic, anti-bacterial, anti-smudge, and anti-fingerprint properties. By using an anti-smudging top coating layer, the surface of the housing may be smudge free.

[0050] The top coating layer can have a total thickness of from about 10 μm to about 25 μm , such as about 15 μm to about 20 μm .

[0051] The top coating layer may comprise a bottom layer and a top layer coated or deposited on the bottom layer. The bottom layer may comprise a polyurethane polymer. The top layer may comprise a UV top coat. The UV top may, for example, be a resin, such as a polyacrylic resin, a polyurethane resin, a urethane acrylate resin, an acrylic acrylate resin or an epoxy acrylate resin.

[0052] When the top coating layer comprises a bottom layer and a top layer, then both the bottom layer and the top layer may be transparent.

[0053] The first coated surface may comprise an oxidized layer and a coating layer. The coating layer may be disposed on the oxidized layer.

[0054] In one example, the first coated surface comprises a single layer, such as an oxidized layer or a coating layer. In general, the single layer may be a coating layer selected from the group consisting of selected from a base coating layer, a primer coating layer, a powder coating layer and a top coating layer. The coating layer may be disposed directly on to the first surface of the substrate.

[0055] In another example, the first coated surface comprises a plurality of layers. An oxidized layer or a powder coating layer, as described in the present disclosure, may be disposed directly on to the first surface of the substrate. The oxidized layer or the powder coating layer provides a first layer of the first coated surface. The first layer is on the first surface of the substrate.

[0056] The first coated surface may comprise a coating layer, as described in the present disclosure, disposed on the first layer. The coating layer provides a second layer of the first coated surface. When the first layer is a powder coating layer, then either (a) the second layer is a different powder coating layer to the powder coating layer of the first layer or (b) the second layer is not a powder coating layer.

[0057] The second layer of the first coated surface may be a primer coating layer.

[0058] The first coated surface may comprise a coating layer disposed on the second layer. The coating layer provides a third layer of the first coated surface. The third layer is different to the second layer, such as when the second layer is a primer coating layer, then either (a) the third layer is a different primer coating layer to the primer coating layer of the second layer or (b) the third layer is not a primer coating layer.

[0059] The third layer of the first coated surface may be a base coating layer.

[0060] The presence of a first coated surface having multiple layers on the substrate allows the formation of patterns on the layers through laser etching or a computer numeric control (CNC) process. A variety of patterned features can be readily formed, which can provide a distinct finish on the sidewalls or surfaces of the housing.

[0061] As will be explained below, the first coated surface is cut to expose a non-oxidized surface of the substrate. This process may remove part of the first coated surface that was previously applied.

Second coated surface

[0062] The substrate has a second coated surface, where a second surface is coated with a layer. In general, the layer is transparent. Thus, the second coated surface comprises a transparent layer coated on a non-oxidized surface of the substrate. The second coated surface may comprise a transparent layer coated directly on to a surface of the substrate, which is the non-oxidized surface of the substrate.

[0063] The second surface is a non-oxidized surface of the substrate. The second surface may be obtained by cutting the first coated surface of the substrate

using, for example, laser etching or a computer numeric control (CNC) process, to expose a non-oxidized surface of the substrate.

[0064] The non-oxidized surface of the substrate is an uncoated surface of the substrate that has not undergone substantial oxidation, so that, for example, it retains its metallic appearance. The non-oxidized surface of the substrate does not include a surface of the substrate coated with a non-oxidized layer, such as the coatings described above.

[0065] In an example, the layer may comprise a chelating agent and a metal ion or a chelated metal complex thereof, or a mixture of the chelating agent, the metal ion and the chelated metal complex. The layer may be transparent. The chelated metal complex comprises a ligand coordinated to the metal ion. The ligand is the chelating agent.

[0066] In another example, the layer may comprise a sol-gel coating or a sol-gel hybrid coating. The layer may be transparent.

[0067] In another example, the layer may comprise a coating of (i) a chelating agent and a metal ion or a chelated metal complex thereof, and (ii) a sol-gel coating or a sol-gel hybrid coating. The coatings may be transparent.

[0068] By coating the non-oxidized surface of the substrate with such a layer it is possible to both protect and retain the attractive, shiny appearance of the underlying metallic substrate. The layer of the second coated surface can provide a glossy or metallic lustre feeling, such as when used with a magnesium alloy substrate. Unlike coatings formed by electroplating processes, the layer can protect the exposed, underlying surface from corrosion. The second coated surface can show good resistance as tested using a salt fog test, such as ASTM B117, particularly when compared to coatings formed by electroplating.

[0069] The layer comprising the chelating agent and the metal ion or the chelated metal complex may have a thickness of about 30 nm to about 1 μm , such as from about 200 nm to about 750 nm. The layer provides a thin, protective layer for the exposed surface of the substrate.

[0070] The chelating agent may be selected from ethylenediaminetetraacetic acid (EDTA), ethylenediamine (EN), nitrilotriacetic acid (NTA), diethylenetriamine-

penta(methylenephosphonic acid) (DTPPH) and 1-hydroxyethane-1,1-disphosphonic acid (HEDP). In one example, the chelating agent is DTPPH.

[0071] The metal ion is selected from an aluminum ion, a nickel ion, a chromium ion, a tin ion, an indium ion and a zinc ion. In one example, the metal ion is selected from an aluminum ion, a nickel ion and a zinc ion.

[0072] In one example, the chelated metal complex may comprise DTPPH chelated to an aluminum ion. In another example, the chelated metal complex may comprise DTPPH chelated to a nickel ion. In a further example, the chelated metal complex may comprise DTPPH chelated to a zinc ion.

[0073] The layer may comprise a sol-gel coating or a sol-gel hybrid coating. The sol-gel coating may comprise an inorganic oxide, such as an oxide of aluminum, an oxide of silicon, an oxide of titanium or an oxide of zirconium. The sol-gel hybrid coating may comprise the inorganic oxide in combination with a polymer, such as polyurethane or an epoxy resin.

[0074] When the layer comprises two coatings, namely a coating of (i) a chelating agent and a metal ion or a chelated metal complex thereof, and (ii) a sol-gel coating or a sol-gel hybrid coating, then a first coating may comprise the chelating agent and the metal ion or the chelated metal complex, and a second coating may comprise the sol-gel coating or the sol-gel hybrid coating. The second coating may be disposed on the first coating.

Housing

[0075] Housings made from metallic substrates can be light-weight and durable, but can have poor color stability, hardness and chemical resistance. It is difficult to provide a metallic housing having an attractive surface finish and a pleasant tactile texture.

[0076] As described in the present disclosure, the housing is made from a metallic substrate. The metallic substrate can be light-weight and may provide a durable housing. The housing of the present disclosure may have cosmetic features that are visually appealing to a user, such as an attractive surface finish, and it may have a design features with a pleasant texture.

[0077] The housing may be obtained from the method of the manufacturing of the present disclosure.

[0078] In the present disclosure, the housing may comprise a third coated surface. The third coated surface may be disposed on the first coated surface and/or the second coated surface. The third coated surface may provide the housing with additional protection.

[0079] In one example, the third coated surface is disposed or coated on the first coated surface and the second coated surface. The third coated surface may be a single coating that covers both the first and second coated surfaces.

[0080] In general, the third coated surface may comprise a top coating layer. The top coating layer, such as described for the first coated surface. The top coating layer may comprise a polymer selected from a polyurethane, a polycarbonate, a urethane acrylate, a polyacrylate, a polystyrene, a polyetheretherketone, a polyester, a polyester-polyether copolymer, a polyamide-polyether copolymer, nylon, a fluoropolymer and a mixture thereof. In one example, the top coating layer comprises a polyurethane polymer.

[0081] The top coating layer may be transparent. This is to allow the exposed surface of the substrate to be visible through the top coating layer.

[0082] The top coating layer may have hydrophobic, anti-bacterial, anti-smudge, and anti-fingerprint properties. By using an anti-smudging top coating layer, the surface of the housing may be smudge free.

[0083] The third coated surface may comprise two layers. The third coated surface may comprise a first coating layer and a second coating layer. The second coating layer may be disposed on the first coating layer. Both the first coating layer and the second coating layer may each be disposed or coated on the first coated surface and the second coated surface. Thus, the first coating layer may be a single coating that covers both the first and second coated surfaces. The second coating layer may be a single coating that covers the first coating layer.

[0084] The first coating layer and the second coating layer may each be transparent. The exposed surface of the substrate can then be seen through the first coating layer and the second coating layer.

[0085] In one example, the first coating layer may comprise a polymer. The polymer may be selected from a polyurethane, a polycarbonate, a urethane acrylate, a polyacrylate, a polystyrene, a polyetheretherketone, a polyester, a polyester-polyether copolymer, a polyamide-polyether copolymer, nylon, a fluoropolymer and a mixture thereof. The second coating layer may be a UV coating. The UV top may, for example, be a resin, such as a polyacrylic resin, a polyurethane resin, a urethane acrylate resin, an acrylic acrylate resin or an epoxy acrylate resin.

[0086] In another example, the first coating layer comprises a polyurethane polymer and the second coating layer is a UV coating.

[0087] The housing is for an electronic device having an electrical circuit. In the housing of the present disclosure, the first coated surface and the second coated surface of the housing may be external to the electrical circuit. When the housing has a third coated surface, then the third coated surface may be external to the electrical circuit.

[0088] The housing may provide an exterior part of the electronic device, such as a cover or a casing of the electronic device. The housing may include a support structure for an electronic component of the electronic device.

[0089] The housing may include a battery cover area, a battery door or a vent.

[0090] The housing may provide a substantial part of the cover or the casing of the electronic device. The term "substantial part" in this context refers to at least about 50 %, such as at least about 60 %, at least about 70 %, at least about 80 % or at least about 90 %, of the total weight of the cover or the casing. The housing may provide the entire cover or casing of the electronic device.

[0091] The housing can be a cover, such as a lid, the casing or both the cover and the casing of the electronic device. The casing may form a bottom or lower part of the cover of the electronic device. In one example, the housing is the casing of a laptop, a tablet or a cell phone.

[0092] The first coated surface of the housing may provide an exterior cover or an exterior casing of the electronic device. The first coated surface may provide a bezel for a display screen, or a casing and/or wrist rest for a keyboard.

[0093] The second coated surface of the housing may provide a surface that forms an edge or part of a peripheral area of a tactile device of the electronic device. The second coated surface may provide an edge or a peripheral area in the housing for a touchpad, a fingerprint scanner, a trackball, a pointing stick, or a button, such as a mouse button or a keyboard button.

[0094] An example of a housing of the present disclosure is shown in Figure 2, which is a partial cross section through the housing. The housing has a substrate 200 with an oxidized layer 205 and a coating layer 210. The oxidized layer 205 and the coating layer 210 form the first coated surface of the substrate 200. A layer 220 is coated onto a non-oxidized surface of the substrate 200. The layer comprises a chelated metal complex or a sol-gel coating. The layer 220 is transparent and forms the second coated surface of substrate 200.

[0095] Figure 3 shows a partial cross section of another example of a housing of the present disclosure. As in Figure 2, the substrate 200 has an oxidized layer 205 and a coating layer 210, which form the first coated surface of the substrate 200. A transparent layer 220 comprising a chelated metal complex is coated onto a non-oxidized surface of the substrate 200. A sol-gel coating or a sol-gel hybrid coating 230 is coated onto the transparent layer 220 comprising the chelated metal complex. The combination of the sol-gel containing coating 230 and the transparent layer 220 form the second coated surface of substrate 200.

[0096] Another example of a housing of the present disclosure is shown in Figure 4. This partial cross section through the housing shows a substrate 200 with either (a) an oxidized layer 205 and a coating layer 210 or (b) two different coating layers 205 and 210. The layers 205 and 210 form the first coated surface of the substrate 200. A transparent layer 220 is coated onto a non-oxidized surface of the substrate 200. The transparent layer 220 comprises a chelated metal complex or a sol-gel coating. The transparent layer forms the second coated surface of substrate 200. The housing also has a top coating layer 240 that covers both the first and second coated surfaces. The top coating layer 240 forms a third coated surface of the substrate 200.

[0097] Figure 5 shows another example of a housing of the present disclosure. The partial cross section shows a substrate 200 with either (a) an oxidized layer

205 and a coating layer 210 or (b) two different coating layers 205 and 210. The layers 205 and 210 form the first coated surface of the substrate 200. A transparent layer 220 is coated onto a non-oxidized surface of the substrate 200. The transparent layer 220 comprises a chelated metal complex. The transparent layer forms the second coated surface of substrate 200. The housing also has a first coating layer 240 and a second coating layer 250. The first coating layer 240 covers both the first and second coated surfaces. The second coating layer 250 covers the first coating layer 240. The first and second coating layers 240, 250 form a third coated surface of the substrate 200.

[0098] Figure 6 shows a partial cross section of another example of a housing of the present disclosure. The substrate 200 has either (a) an oxidized layer 205 and two coating layers 210, 215 or (b) three different coating layers 205, 210 and 215. The layers 205, 210 and 215 form the first coated surface of the substrate 200. Layer 220 comprises a chelated metal complex or a sol-gel coating, and is disposed on a non-oxidized surface of the substrate 200. Layer 220 forms a second coated surface of the substrate 200.

[0099] Figure 7 shows a partial cross section of another example of a housing of the present disclosure. As in Figure 6, the substrate 200 has a first coated surface formed from either (a) an oxidized layer 205 and two coating layers 210, 215 or (b) three different coating layers 205, 210 and 215. A transparent layer 220 comprising a chelated metal complex is coated onto a non-oxidized surface of the substrate 200. A sol-gel coating 230 or a sol-gel hybrid coating 230 is coated onto the transparent layer 220 comprising the chelated metal complex. The combination of the sol-gel containing coating 230 and the transparent layer 220 form the second coated surface of substrate 200. The housing also has a first coating layer 240 and a second coating layer 250. The first coating layer 240 covers both the first and second coated surfaces. The second coating layer 250 covers the first coating layer 240. The first and second coating layers 240, 250 form a third coated surface of the substrate 200.

[0100] Figure 8 shows an example of a housing of the present disclosure. The housing is a casing 300 for a keyboard of a laptop. The first coated surface 310 provides a wrist rest and cover for the laptop. The housing has two second coated

surfaces 320 and 330. One of these surfaces 320 provides was diamond cut from the main casing and forms an edge around a touchpad. The other surface 330 was also diamond cut from the main casing and provides an edge around a fingerprint scanner. Both surfaces have an attractive appearance and a provide a pleasant tactile surface.

Method of manufacture

[0101] The present disclosure also relates to a method of manufacturing a housing for an electronic device.

[0102] The first coated surface of a substrate is cut to expose a non-oxidized surface of the substrate. This process removes a part of the first coated surface, including, for example, any oxidized layers to expose a shiny surface of the underlying substrate. Part of the first coated surface of the substrate is retained after the cutting process.

[0103] The first coated surface of the substrate may be cut to form a predefined pattern or shape. The cutting process may allow the formation of patterns that will provide a second coated surface having a texture or finish that is different to the texture or finish of the first coated surface.

[0104] The cutting of the first coated surface to expose a non-oxidized surface of the substrate may be by laser cutting or etching, or Computer Numeric Control (CNC) cutting. When the cutting is by laser etching, then, for example, a logo may be formed on the substrate of the housing

[0105] In one example, the cutting is by CNC cutting.

[0106] The method of the present disclosure may include preparing the first coated surface of the substrate. The first coated surface of the substrate is prepared before it is cut to expose a non-oxidized surface of the substrate.

[0107] When the first coated surface comprises an oxidized layer, then the method may involve preparing an oxidized layer on a first surface of the substrate.

[0108] The oxidized layer may comprise a passivation layer. The substrate, such as a first surface of the substrate, may be coated with a salt selected from a molybdate salt, a vanadate salt, a phosphate salt, a chromate salt, a stannate salt and a manganese salt. A solution of the salt may be coated onto the substrate.

[0109] The oxidized layer may comprise an oxidized layer of the metallic substrate.

[0110] The oxidized layer may comprise a micro-arc oxide layer, such as a micro-arc oxide layer of the magnesium alloy. The micro-arc oxide layer is prepared by micro-arc oxidation of the substrate, such as a first surface of the substrate.

[0111] Micro-arc oxidation (MAO) is an electrochemical oxidation process that can, for example, generate an oxidized layer on a metallic substrate, such as a substrate comprising a magnesium alloy. MAO involves creating micro-discharges on a surface of the magnesium alloy immersed in an electrolyte to produce a crystalline oxide coating. The resulting micro-arc oxide layer may be ductile and have a relatively high hardness. Unlike anodizing processes, MAO employs a high potential such that discharges occur. The resulting plasma can modify the structure of the oxide layer. MAO is a chemical conversion process that causes oxidation of the underlying magnesium alloy material, instead of an oxide layer being disposed on to a surface of the magnesium alloy. In comparison to an oxide layer produced by a deposition process, a micro-arc oxide layer may have a higher adhesion to the underlying magnesium alloy.

[0112] The electrolytic solution for MAO may comprise an electrolyte selected from sodium silicate, sodium phosphate, potassium fluoride, potassium hydroxide, sodium hydroxide, fluorozirconate, sodium hexametaphosphate, sodium fluoride, aluminum oxide, silicon dioxide, ferric ammonium oxalate, a salt of phosphoric acid, polyethylene oxide alkylphenolic ether and a combination thereof.

[0113] When the oxidized layer comprises two layers, such as a passivation layer and an oxidized layer of the metallic substrate, then each layer is prepared in a stepwise manner. Thus, for example, the oxidized layer of the metallic substrate, such as a micro-arc oxide layer, may be prepared before the passivation layer.

[0114] When the first coated surface comprises a coating layer, then the method may involve preparing a coating layer on a first surface of the substrate, such as described in the present disclosure. A coating layer selected from a base coating layer, a primer coating layer, a powder coating layer and a top coating layer may be applied to a first surface of the substrate.

[0115] In one example, the first coated substrate comprises an oxidized layer and a coating layer. The oxidized layer is prepared on a first surface of the substrate. The coating layer is then deposited or prepared on the oxidized layer.

[0116] Each coating layer or oxidized layer may be applied to achieve a desired thickness. The thickness of each layer can be measure after it has been applied using, for example, a micrometer screw gauge.

[0117] After cutting the first coated surface of the substrate to expose a non-oxidized surface of the substrate, the non-oxidized surface is coated with a layer comprising (i) a chelating agent and a metal ion or a chelated metal complex thereof, or (ii) a sol-gel coating or a sol-gel hybrid coating.

[0118] A solution comprising the chelating agent and the metal ion, the chelated metal complex or a mixture thereof may be coated onto the non-oxidized surface of the substrate. The solution may be sprayed, rolled or brushed onto the non-oxidized surface.

[0119] The layer comprising a chelating agent and a metal ion or a chelated metal complex thereof may be formed under acidic conditions, such as at a pH of from about 2 to about 6. Thus, the solution coated onto the substrate that comprises the chelating agent and the metal ion, the chelated metal complex or a mixture thereof may have a pH of from about 2 to about 6.

[0120] The method may involve coating the non-oxidized surface of the substrate with a layer comprising a sol-gel coating or a sol-gel hybrid coating.

[0121] The sol-gel coating may be formed by applying a precursor of an inorganic oxide, such as a metal alkoxide or an alkylorthosilicate. Examples include aluminum isopropoxide, tetraethylorthosilicate (TEOS), tetramethylorthosilicate (TMOS), titanium isopropoxide and zirconium tert-butoxide.

[0122] The sol-gel hybrid coating may be formed by applying the precursor of the inorganic oxide and a polymer, such as polyurethane or an epoxy resin.

[0123] When the second coated surface comprises a coating of (i) a chelating agent and a metal ion or a chelated metal complex thereof, and (ii) a sol-gel coating or a sol-gel hybrid coating, then a sol-gel coating or a sol-gel hybrid coating may be applied on to the coating comprising the chelating agent and the metal ion, the chelated metal complex or a mixture thereof.

[0124] The method of manufacturing a housing may involve coating both the first coated surface of the substrate and a second coated surface with a transparent top coating layer. This transparent top coating layer may form, or be part of, a third coated surface of the substrate.

[0125] A third coated surface of the substrate may be prepared by applying a top coating layer onto the first coated surface and/or the second coated surface. The top coating layer may be applied onto both the first coated surface and the second coated surface, such as in a single coating step.

[0126] When the third coated surface comprises a first coating layer and a second coating layer, then the first coating layer is applied onto the first coated surface and the second coated surface, and then the second coating layer is applied onto the first coating layer.

[0127] An example of a method of manufacturing a housing of the present disclosure is schematically shown in Figure 1. In (a), a substrate 100 having a first coated surface 110 is shown. The first coated surface 110 is cut to expose a non-oxidized surface of the substrate 130, as shown in (b). The non-oxidized surface 130 is then coated with a layer 120 comprising (i) a chelating agent and a metal ion or chelated metal complex thereof, or (ii) a sol-gel coating or a sol-gel hybrid coating, as shown in (c).

Electronic device

[0128] The electronic device of the present disclosure may be a computer, a cell phone, a portable networking device, a portable gaming device or a portable GPS. The computer may be portable. When the computer is portable, it may be a laptop or a tablet.

[0129] The electronic device has an electrical circuit, such as a motherboard or display circuitry. The housing may be external to the electrical circuit.

EXAMPLES

[0130] The present disclosure will now be illustrated by the following non-limiting example.

Example 1

[0131] A keyboard casing for a laptop was manufactured from a magnesium alloy substrate. An oxidized surface layer was formed on the magnesium alloy substrate by micro-arc oxidation. The oxidized surface layer was then coated with a primer coating layer. The primer coating layer of polyester was then coated with a base coating layer of polyurethane. The combination of the micro-arc oxidation layer, the primer coating layer and the base coating layer formed a first coated surface of the substrate.

[0132] The substrate was then cut using a CNC cutting process to expose a non-oxidised surface of the substrate. The CNC cutting process was used to cut openings in the casing for a touchpad and for a fingerprint scanner.

[0133] The shiny, exposed areas of the substrate were then coated with a solution comprising a chelated metal complex where the chelating agent is DTTPH and the metal ion was at least one of aluminum, nickel and zinc. The solution was dried and formed a transparent coating layer that protects the underlying metallic surface of the substrate and prevents it from undergoing atmospheric oxidation. The attractive surface appearance of the substrate was visible through the layer. This coating formed a second coated surface of the substrate.

[0134] A transparent top coating layer of urethane acrylate was applied onto the substrate and covered both the first coated surface and the second coated surface. The attractive metallic lustre of the magnesium alloy substrate remained visible through the top coating layer.

CLAIMS

1. A housing for an electronic device comprising:
a substrate comprising a magnesium alloy, which substrate has a first
5 coated surface and a second coated surface;
wherein the first coated surface comprises an oxidized layer or at least one
coating layer; and
wherein the second coated surface comprises a layer coated on a non-
oxidized surface of the substrate, wherein the layer comprises (i) a chelating agent
10 and a metal ion or a chelated metal complex thereof, or (ii) a sol-gel coating or a
sol-gel hybrid coating.
2. The housing of claim 1, wherein the layer coated on a non-oxidized surface
of the substrate comprises a chelating agent and a metal ion or a chelated metal
15 complex thereof, and the chelating agent is selected from
ethylenediaminetetraacetic acid, ethylenediamine, nitrilotriacetic acid,
diethylenetriaminepenta(methylenephosphonic acid) and 1-hydroxyethane-1,1-
disphosphonic acid.
- 20 3. The housing of claim 1, wherein the layer coated on a non-oxidized surface
of the substrate comprises a chelating agent and a metal ion or a chelated metal
complex thereof, and the metal ion is selected from an aluminum ion, a nickel ion,
a chromium ion, a tin ion, an indium ion and a zinc ion.
- 25 4. The housing of claim 1, wherein the layer coated on a non-oxidized surface
of the substrate comprises a sol-gel coating or a sol-gel hybrid coating.
5. The housing of claim 4, wherein the layer coated on a non-oxidized surface
of the substrate comprises a sol-gel coating, wherein the sol-gel coating comprises
30 an inorganic oxide selected from an oxide of aluminum, an oxide of silicon, an
oxide of titanium and an oxide of zirconium.

6. The housing of claim 4, wherein the layer coated on a non-oxidized surface of the substrate comprises a sol-gel hybrid coating, wherein the sol-gel hybrid coating comprises an inorganic oxide and a polymer, wherein the inorganic oxide is selected from an oxide of aluminum, an oxide of silicon, an oxide of titanium and an oxide of zirconium.

7. The housing of claim 1, wherein the first coated surface comprises at least one coating layer selected from a base coating layer, a primer coating layer, a powder coating layer and a top coating layer.

8. The housing of claim 1, wherein the oxidized layer comprises a salt selected from a molybdate salt, a vanadate salt, a phosphate salt, a chromate salt, a stannate salt and a manganese salt.

9. The housing of claim 1, wherein the layer coated on a non-oxidized surface of the substrate has a thickness of about 30 nm to about 1 μm .

10. A method of manufacturing a housing for an electronic device, comprising: cutting a first coated surface of a substrate to expose a non-oxidized surface of the substrate, wherein the substrate comprises a magnesium alloy, and the first coated surface comprises an oxidized layer or at least one coating layer; and

coating the non-oxidized surface of the substrate with a layer comprising (i) a chelating agent and a metal ion or a chelated metal complex thereof, or (ii) a sol-gel coating or a sol-gel hybrid coating.

11. The method of claim 10, comprising: coating the non-oxidized surface of the substrate with a layer comprising a sol-gel coating or a sol-gel hybrid coating.

12. The method of claim 10, further comprising:

coating both the first coated surface of the substrate and a second coated surface with a transparent top coating layer, wherein the second coated surface comprises the layer coated on to the non-oxidize surface of the substrate.

5 13. The method of claim 10, wherein the layer coated on a non-oxidized surface of the substrate comprises a chelating agent and a metal ion or a chelated metal complex thereof, and the chelating agent is selected from ethylenediaminetetraacetic acid, ethylenediamine, nitrilotriacetic acid, diethylenetriaminepenta(methylenephosphonic acid) and 1-hydroxyethane-1,1-
10 disphosphonic acid.

14. The method of claim 10, wherein the layer coated on a non-oxidized surface of the substrate comprises a chelating agent and a metal ion or a chelated metal complex thereof, and the metal ion is selected from an aluminum ion, a
15 nickel ion, a chromium ion, a tin ion, an indium ion and a zinc ion.

15. An electronic device comprising:
an electrical circuit; and
a housing external to the electrical circuit, wherein the housing comprises:
20 a substrate comprising a magnesium alloy, which substrate has a first coated surface and a second coated surface;
wherein the first coated surface comprises an oxidized layer or at least one coating layer; and
wherein the second coated surface comprises a layer coated on a non-
25 oxidized surface of the substrate, wherein the layer comprises (i) a chelating agent and a metal ion or a chelated metal complex thereof, or (ii) a sol-gel coating or a sol-gel hybrid coating.

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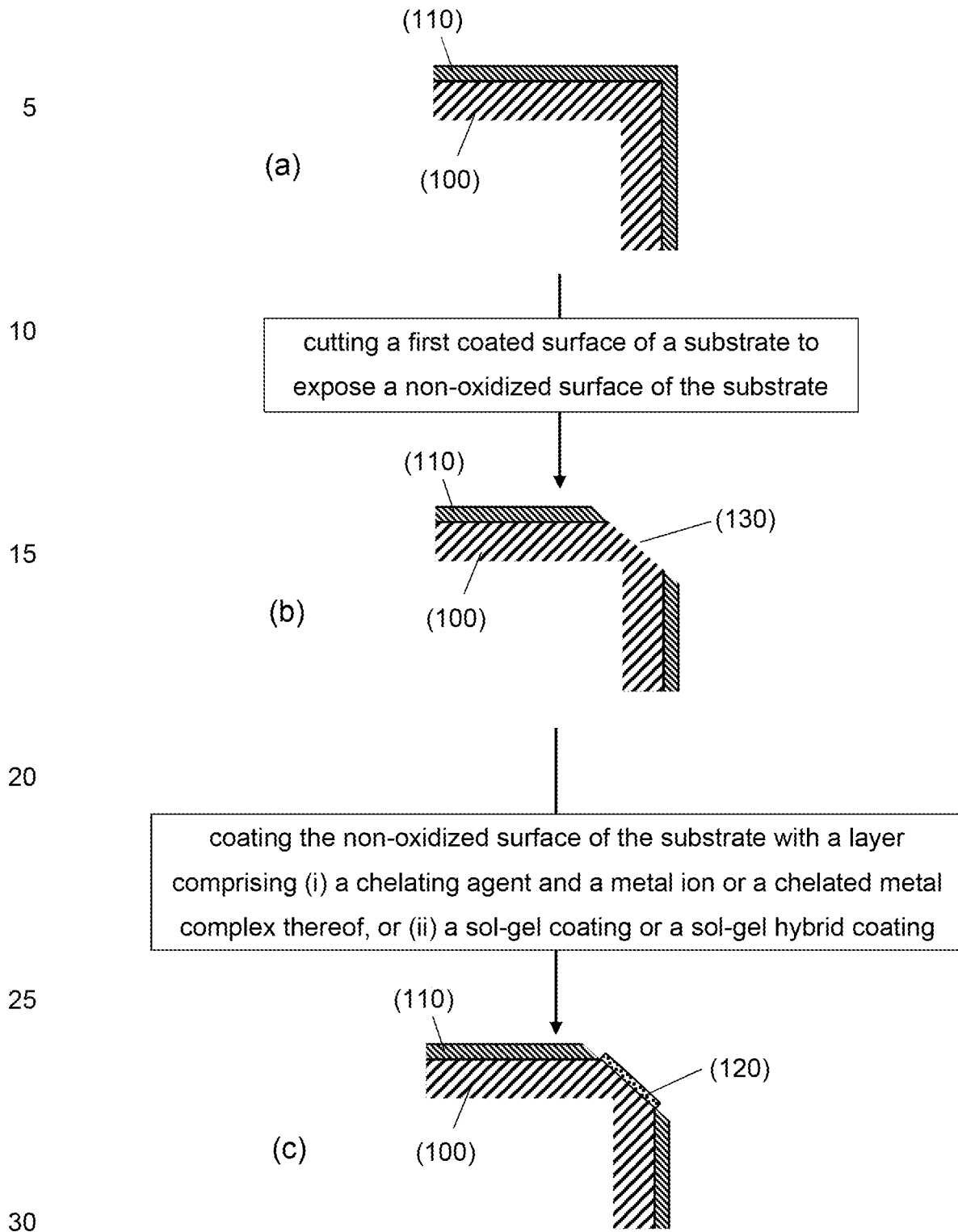
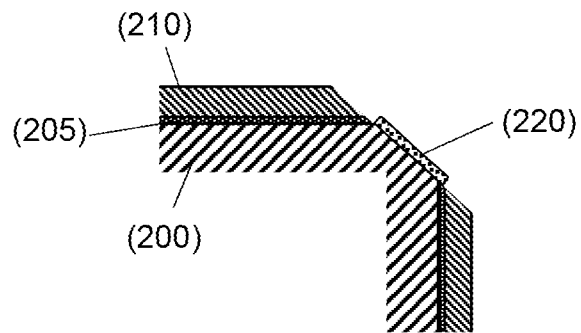


Figure 1

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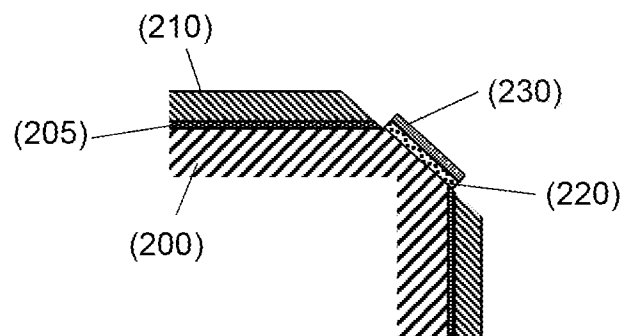
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Figure 2

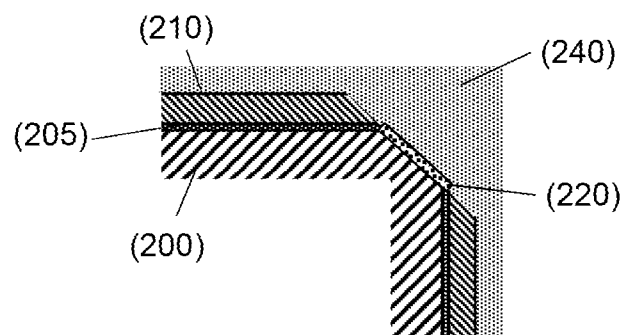
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Figure 3

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Figure 4

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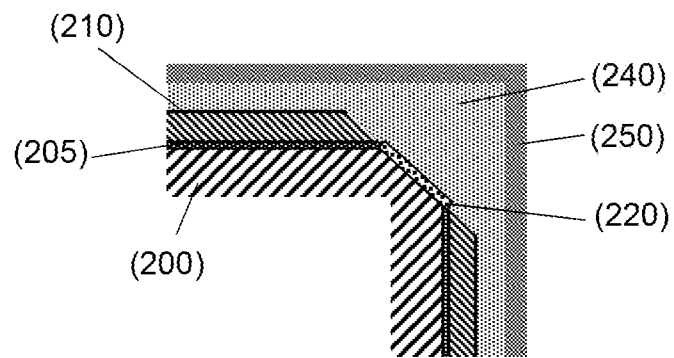


Figure 5

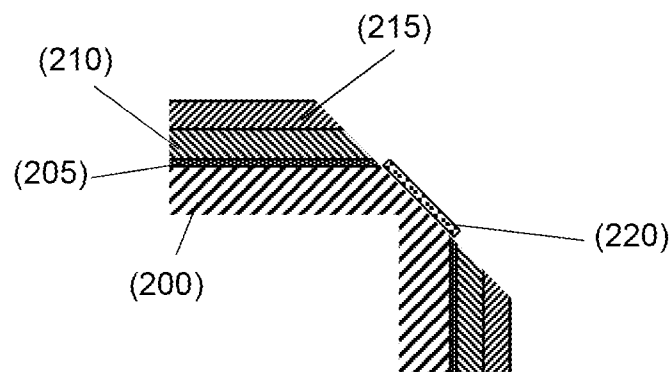


Figure 6

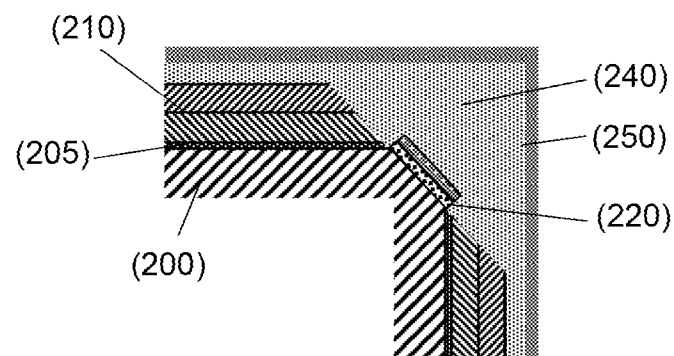
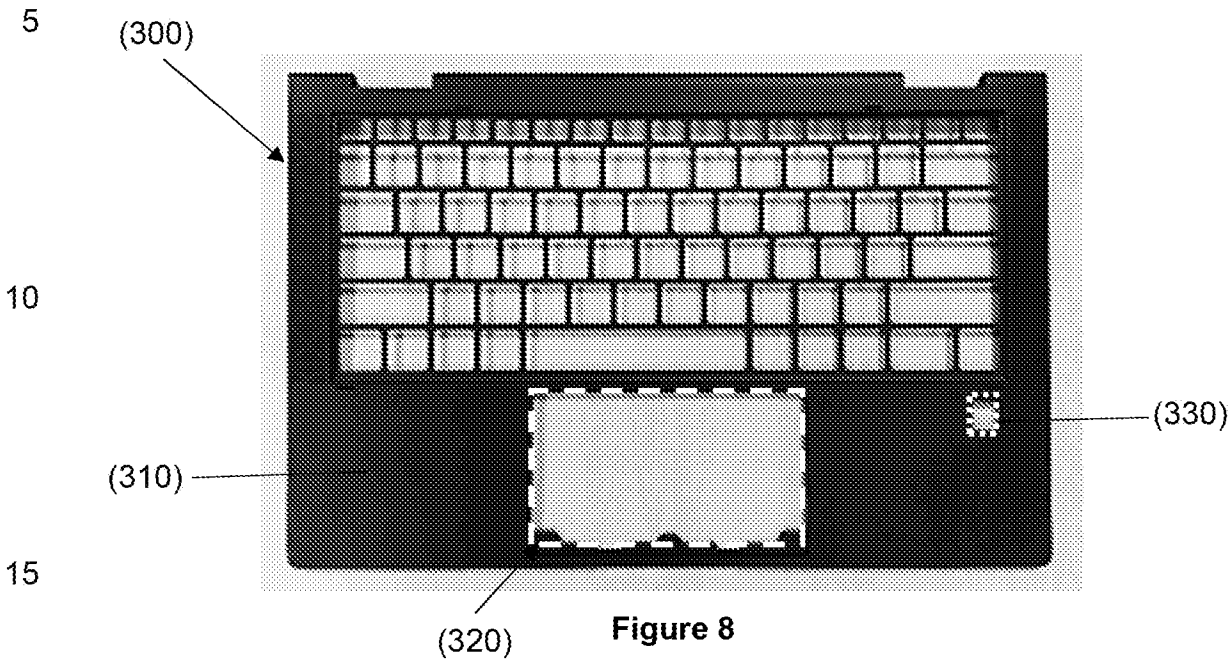


Figure 7



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 2019/012808

A. CLASSIFICATION OF SUBJECT MATTER				
<i>C23C 28/00 (2006.01)</i> <i>B32B 15/00 (2006.01)</i> <i>H05K 5/04 (2006.01)</i> <i>B32B 33/00 (2006.01)</i>				
According to International Patent Classification (IPC) or to both national classification and IPC				
B. FIELDS SEARCHED				
Minimum documentation searched (classification system followed by classification symbols)				
C23C 28/00, B32B 15/00, H05K 5/04, B32B 33/00				
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched				
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)				
PatSearch (RUPTO internal), USPTO, PAJ, Esp@cenet, DWPI, EAPATIS, PATENTSCOPE, Information Retrieval System of FIPS				
C. DOCUMENTS CONSIDERED TO BE RELEVANT				
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.		
A	CN 101153394 A (BYD CO LTD) 02.04.2008	1-15		
A	WO 2015/199646 A1 (HEWLETT-PACKARD DEVELOPMENT COMPANY, L. P.) 30.12.2015	1-15		
A	US 8687353 B2 (PANASONIC CORP) 01.04.2014	1-15		
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.				
<table border="0" style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;"> * Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “E” earlier document but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed </td> <td style="width: 50%; vertical-align: top;"> “T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family </td> </tr> </table>			* Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “E” earlier document but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed	“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family
* Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “E” earlier document but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed	“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family			
Date of the actual completion of the international search		Date of mailing of the international search report		
05 September 2019 (05.09.2019)		12 September 2019 (12.09.2019)		
Name and mailing address of the ISA/RU: Federal Institute of Industrial Property, Berezhkovskaya nab., 30-1, Moscow, G-59, GSP-3, Russia, 125993 Facsimile No: (8-495) 531-63-18, (8-499) 243-33-37		Authorized officer I. Eliseeva Telephone No. (499) 240-25-91		